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DEGRADED EFFECTIVENESS STUDIES FOR MAJOR DEVELOPMENTAL SYSTEMS AND HIGH-DENSITY ITEMS

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September 1985

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Soldier performance when operating military systems while wearing chemical protective clothing at the most protective level, Mission Oriented Protective Posture (MOPP) level IV is a vital concern to commanders. The analysis of a soldier's degraded effectiveness provides insight into the interrelationships, between these systems and the operators. Fourteen Army systems were identified by USANCA for evaluation of combatability, these were missions for: M1E1 tank, M-3 Bradley, XM270 Multiple Launched Rocket System, M249 Squad Automatic Weapon,
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AH64 Advanced Attack helicopter, HMMWV High Mobility Multi-Purpose Wheeled Vehicle, Grader, XM21 Chemical Monitoring System, AN/VDR-2 Radic Set, MEDBN aid station, SINGARS, MCS and the PLRS. Twelve-hour Mission Profiles were developed from related documents for each system. Critical tasks were extracted from these Profiles and divided into their respective time-action components. The BRL Chemical Protection Degradation Model was used to evaluate the degraded effectiveness of individuals and teams performing the specific tasks at MOPPIV. Degraded effectiveness factors were tabulated for each system by task. Factors were determined for 45 different tasks. One task which effects all missions is radio communication, which is degraded to 0.30. Road movement was found to be moderately degraded (0.87) where fire missions, loading activities and instrument reading functions were degraded to approximately 0.50. It is felt that a number of modifications of equipment and redesign of the MOPP ensemble may result in improved compatibility and a number of specific recommendations are made.

The results of this study provide valuable data to the battlefield commander for evaluating the penalties he must endure because his troops must wear the MOPPIV gear while performing mission critical tasks. Further, the recommendations for improvements are valuable guidelines to the material developer.

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I. INTRODUCTION

The Army Materiel System Analysis Activity (AMSAA) was tasked by the United States Army Nuclear and Chemical Agency (USANCA) to evaluate the survivability/sustainability of major US Army developmental systems in a NBC environment. Three areas were of interest: decontaminability, hardness and compatibility. The Vulnerability Lethality Division of the Ballistic Research Laboratory was asked to evaluate compatibility of fourteen systems (Table 1) with operators in chemical protective clothing. This clothing, referred to as Mission Oriented Protective Posture (MOPP) may be worn to provide various levels of protection. The most protective, level IV, requires all equipment to be worn and sealed. We will refer to this protection as MOPPIV through the remainder of this report. The physiological abilities of personnel functioning in this equipment are encumbered by the restriction of the MOPP gear. Restriction manifested by a decrease in rate to accomplish a particular task, or a decrease in the accuracy of completing a task or a combination of changes in both rate and accuracy. For the purpose of this study, degradation is defined as the difference between the time to accomplish a task in Battle Dress Uniform (BDU) and accomplishing the same task in MOPPIV. This task was divided in two parts: first, determine 12 hour mission profiles and second, calculate degraded effectiveness.

TABLE 1. SYSTEMS EVALUATED

M1E1	Main Battle Tank
M-3	Bradley Fighting Vehicle System
XM270	Multiple Launched Rocket System
M249	Squad Automatic Weapon
AH64	Advanced Attack Helicopter
HMMWV	High Mobility Multi-Purpose Wheeled Vehicle
Grader	Motorized,DED Heavy,Combat Construction Equipment
XM21	Chemical Monitoring System
AN/VDR-2	Radic Set
MED BN	Aid Station Operations
SINGARS	Small Unit Radio
MCS	Maneuver Control System
PLRS	Position Location Reporting System

II. APPROACH

1. Mission Profiles

Mission profiles were developed for typical 12 hour combat scenarios. Mission profiles contain a complete listing of unit mission, tasks to be accomplished, time to complete each task, and references. The unit mission is the specific overall duty of the day. From the mission statement sub-tasks were identified.

Each sub-task is a listing of short duration tasks that are repeated during the day. The time is that interval normally needed to accomplish a given sub-task. References are primary sources, typically from the associated schools, testing agencies, developmental agencies, field manuals, technical manuals, reliability operability compatibility studies and developmental and operational tests. Critical tasks were identified, extracted from the scenario and defined in terms of the following physiological and related functions:

(a) near visual
(b) far visual
(c) oral
(d) aural
(e) manual dexterity
(f) mental acuity
(g) Mobility Encumbrance
(h) heat stress

Several different mission profiles could be created for evaluating a particular system. For example, the Radiac Set could remain stationary or mobile or could be used in a number of different modes. As a result, and based on system documents, mission profiles were selected which represented the most frequent activities. This profile was then compiled in a manner which indicated how much time was expended for a specific task during the 12 hour day. Specific tasks were then listed along with an estimate of the time required to complete one replication. Detailed system information and references are in Appendix A.

2. Degradation

Degraded Effectiveness (E_D) depended only upon the effect of the chemical protective equipment on performance. Other factors such as fatigue, temperature and humidity were not considered. The only E_D values not evaluated as a time dependent function were silent overwatch, receiving messages and aircraft navigation. The E_D for silent overwatch personnel is equal to the number of targets detected in MOPPIV divided by the number of targets detected in BDU over a given period of time. The E_D for personnel receiving messages is equal to the number of words correctly received divided by the number of words sent. The E_D for aircraft navigation was extrapolated from project APACHE as the number of correct responses divided by the number of responses made to directives for headings, altitudes and distances to target areas. Estimated degradation and task completion times are given in Tables 2 through 15.

The contribution of each physiological function was determined and E_D calculated. Calculations for personnel operating in MOPPIV, were made using the BRL MOPP degradation algorithm, a process for ordering and weighting physiological functions. The physiological function values were ordered. Degradation was established in this manner for each event. The algorithm estimates the E_D value which estimates the rate at which a soldier can accomplish a given task; for example, 0.87 refers to 87 percent of capacity. Appendix B lists specific E_D values for the 45 sub-tasks this study.

III. RESULTS AND DISCUSSION

1. M1E1-Main Battle Tank

Ten tasks were identified as critical to the mission profile for the M1E1 (Table 2). Silent overwatch takes one hour of time in BDU or MOPP. The measure of E_D is accuracy of target detection. The physiological factor most degraded for this task was far visual acuity. The tasks identified in Table 2 are discussed in greater detail in Appendix A.

TABLE 2. M1E1 MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU time
Road Movement	0.87	1 Hour
Heavy Maintenance	0.70	2-4 Hours
POL Activity	0.48	15 Minutes
Load Ammunition	0.48	30 Minutes
Brief and Inspect	0.47	45 Minutes
Acquire Targets	0.50	10 Seconds
Fire Mission	0.40	12 Seconds
Movement about BP**	0.46	5 Seconds
Silent Overwatch	0.30	1 Hour
Radio Communications	0.30	10 Seconds/transmission

** During closed hatch operations (acquire/detect targets)

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* J.J. Baldauf and J.T. Klopcic, "BRL Chemical Protection Degradation Model," Draft Technical Report ARBRL-TR, 25 August 1983.

2. M-3 Bradley Fighting Vehicle

Twelve tasks are critical to the 12 hour mission profile for the M-3. A TOW fire mission is degraded during the initiation and shut down phase. During the time of flight phase a loss of accuracy results. Limitations result from near vision acuity and manual dexterity. Tasks identified in Table 3 are discussed in greater detail in Appendix A.

TABLE 3. M-3 BRADLEY FIGHTING VEHICLE 12 HOUR MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Brief and Inspect	0.47	45 Minutes
Road Movement	0.87	1 Hour
Heavy Maintenance	0.70	2-4 Hours
Movement to Contact	0.46	30 Seconds
TOW Fire Mission	0.45	20 Seconds
Main Gun Fire mission	0.34	5 Seconds
Reload TOW	0.48	2 Minutes
Crew Maintenance	0.55	15 Minutes
POL Activity	0.48	3 Minutes
Load 25 MM rounds	0.48	10 Minutes
Acquire Targets	0.50	5 Seconds
Radio Communication	0.30	10 Seconds

3. MLRS (Multiple Launched Rocket System)

The 6 tasks identified as critical are listed in Table 4. Limiting are communications and silent overwatch, due to degraded aural/oral ability and far visual acuity. Communications segments are considerably longer than most transmissions because computational and flight data are transferred over a computer coded net. Tasks identified in Table 4 are discussed further in Appendix A.

TABLE 4. MLRS 12 HOUR MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Fire Mission	0.37	2 Minutes
Travel	0.87	20 Minutes
Load	0.60	5 Minutes
POL	0.48	15 Minutes
Communications	0.30	20 Seconds
Overwatch	0.30	1Hour

4. M 249 (SAW)- Squad Automatic Weapon

A 12 hour Mission profile for the M249 was developed and 6 critical tasks were identified. The limiting task was the fire mission, degradation being due to the loss of far visual acuity. Table 5 contains E_D evaluations for essential tasks. Further discussion concerning these evaluations is contained in Appendix A.

TABLE 5. M 249 (SAW) SQUAD AUTOMATIC WEAPON 12 MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Fire Mission	0.25	3 Second Bursts
Silent Watch	0.30	1 Hour
Run	0.58	10 Seconds
Walk	0.50	20 Minutes
Load	0.30	5 Seconds
Change Barrel	0 .30	3 Seconds
Clear	0.30	5 Seconds

5. AH-64 Attack Helicopter

The mission profile for the AH-64 was developed as two four hour sorties and one four hour reload and ground operation section. The E_D of personnel performing piloting tasks are indicative of increased pilot error during flight (ie. incorrect headings, airspeeds, location reports and flight altitudes) and limited by manual dexterity, near and far vision acuity (Table 6). The tasks specified in Table 6 are discussed further in Appendix A.

TABLE 6. AH 64 MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Target Detection	0.50	7 Seconds
Sight Alignment	0.30	3 Seconds
Fire Mission	0.30	20 Seconds
Target Status Check	0.30	3 Seconds
Read Maps	0.40	30 Minutes
Read Instruments	0.40	30 Minutes
Manual operations	0.30	30 Minutes
A/C Guidance	0.30	30 Minutes

6. High Mobility Multi-Purpose Wheeled Vehicle (HMMWV)

The driver has only two tasks, drive and load/unload. Driving is degraded more than unloading due to the increased need for far visual acuity (Table 7). Further explanations of HMMWV operations are in Appendix A.

TABLE 7. HMMWV 12 HOUR MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Time
Drive	0.41	4 Hours
Load/Unload	0.51	2 Hours

7. Combat Construction Equipment (CCE)

The mission profile for the CCE consists of 8 hours of operation and approximately 4 hours of planning and preparation. The limiting physiological factor is visual acuity; Earth Moving and Snow Removal tasks are affected by the degradation of this factor (Table 8). More detailed discussion is contained in Appendix A.

TABLE 8. COMBAT CONSTRUCTION EQUIPMENT (CCE) 12 HOUR MISSION PROFILE

Task	Degraded Effectiveness MOPP IV	Typical BDU Time
POL Resupply	0.48	15 Minutes
Major Repair	0.70	1 Hour
Travel to Side	0.87	1 Hour
Earth Moving	0.51	4 Hour
Snow Removal	0.51	4 Hour
Plans and Preparation	0.47	1 Hour
Preventative Maintenance	0.55	15 Minutes

8. **XM-21 Chemical Agent Alarm**

The system requires an hour per day to set up and operate. The sight alignment in the employment is the most degraded task, due to reduced visual acuity (Table 9). Further discussion is contained in Appendix A.

TABLE 9. XM 21 CHEMICAL AGENT ALARM MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Brief	0.47	15 Minutes
Employment/Deployment	0.39	30 Minutes
Receive Alarm	0.80	5 Seconds

9. **AN/VDR-2 Radiac Set**

The time to perform reading and recording of data is short compared to the time spent driving and briefing. Recording data is most affected because of the degraded visual and manual dexterity abilities (Table 10). A complete discussion of the analysis is in Appendix A.

TABLE 10. AN/VDR-2 RADIAC SET 12 HOUR MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Brief	0.47	15 Minutes
Drive	0.87	4 Hours
Operation	0.80	5 Minutes
Read Instrument	0.40	5 Minutes
Record Data	0.26	2 Minutes

10. SINGARS Squad Radio

The SINGARS mission profile was developed from the SINGARS Required Operational Capabilities and aid from the systems manager. In the listening mode the E_D value is the percent of messages the operator receives correctly (Table 11). Although field maintenance is a limiting factor due to decreased manual dexterity, the communications is limited due to reductions in aural/oral skills. Further details are in Appendix A.

TABLE 11. SINGARS SQUAD RADIO MISSION PROFILE TASKS

Task Degradation Effectiveness and BDU Times for 12 Hour Mission Profiles		
Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Communications	0.35	2 Hours
Assembly	0.37	5 Minutes
Listen Only	0.48	1 Hour
Walk	0.58	1 Hour
Run	0.50	10 Seconds
Field Maintenance	0.28	1 Minute

11. Maneuver Control System (MCS)

The MCS mission profile was established by using the ROC and associated references as stated in Appendix A. Typing was the most degraded task, a result primarily due to decrease in manual dexterity (Table 12). Further information is contained in Appendix A.

TABLE 12. MCS MANEUVER CONTROL SYSTEM MISSION PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Time
Emplacement/Displacement	0.39	1 Hour
Receive Information	0.48	4 Hours
Send a Report	0.48	1 Hour
Type	0.33	3 Hours

12. Position Location Reporting System (PLRS)

The PLRS mission profile was designed by utilizing the ROC and the aid of the systems manager. Plotting of the PLRS data was limited by reduced near visual acuity, mobility encumbrance and manual dexterity factors (Table 13). Information concerning the profile and the evaluations is in Appendix A.

TABLE 13. PLRS MISSON PROFILE TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Time
Plot Position Data	0.23	1 Hour
Receive Status Reports	0.48	3 Hours
Send Status Reports	0.48	1 Hour
Adjust Equipment	0.37	30 Minutes
Emplace/Displacement	0.39	1 Hour
Road March	0.41	1 Hour
Repair Circuit Board	0.75	6 Minutes
Repair Hardware	0.35	4 Minutes

13. Battalion Aid Station (BAS)

The ROC for the new BAS indicates that the majority of the tasks will be performed in collectively protected areas. The only tasks that are expected to be done outside are listed in Table 14. The unit mission depends on the casualty load. Tasks were evaluated which are likely to be accomplished in the NBC environment outside any collectively protected area. These tasks were degraded by mobility encumbrance (Table 14).

TABLE 14. BATTALION AID STATION

Task	Degraded Effectiveness MOPP IV	Typical BDU Times
Application of a Splint	0.53	1 Minute
Carry a Litter	0.40	1 Minute
Place Patients in Protective Wraps	0.40	4 Minutes

14. Oxygen Generating Equipment (OGE)

The OGE is in the developmental phase, however the LOA indicates the mission, describes the equipment capabilities and references similar hospital units in use at the present time . The system will be utilized as a source of oxygen for field hospitals. Emplacement/displacement is limited by mobility encumbrance factors (Table 15). References are listed in Appendix A.

TABLE 15. OXYGEN GENERATING EQUIPMENT TASKS

Task	Degraded Effectiveness MOPP IV	Typical BDU Time
Emplace/Displacement	0.39	1 Hour
Fill Canister	0.85	10 Minutes
Hook up Hoses	0.37	2 Minutes

IV. OBSERVATIONS

One of the most notable tasks that effects all missions is radio communication. Radio communications are limited because crew members wear the protective mask. It should be noted that this task normally requires only 10 seconds to perform. Considering the need to maintain accuracy at 100 percent, an increase to 33 seconds, is indicated since the task is normally degraded to 0.30. Perhaps this represents an acceptable increase in time for routine missions, however,it could be a critical increase in combat. For this reason it is important to consider the operation, present mission, and MOPP level when discussing degradation. This is particularly important when considering extended operations and crew situations. Other specific information including reference material can be obtained from Appendix A.

This E_D evaluation of personnel in MOPP IV using specified types of equipment highlights the difficulties encountered in an NBC environment. Tasks to be accomplished on a highly technical battlefield demand a high level of proficiency. When the proficiency of an individual is degraded by MOPP, especially due to the interface of MOPP with a particular piece of equipment, an improvement in this condition should be initiated. One problem is interference with a complex system. Improvements should be implemented for both the equipment and the MOPP gear. Appendix C is a listing of suggestions for equipment design changes, based on this review, for improving proficiency while operating in MOPP IV. One suggestion is to automate systems. Automation requires less mobility and manual skills which are limiting factors with present equipment. It is understood that other vulnerability problems occur when equipment is automated. Non-mobile support systems such as the MCS, PLRS, BAS, XM21 and the Oxygen Generating System should be designed to minimize emplacement/displacement procedures. One is to contain these systems in a collectively protected mobile shelter. Visual acuity is one physiological factor that can be greatly improved by mask design, the use of optical devices is difficult with the present MOPP equipment. Manual dexterity used in manipulating knobs, dials etc. can be improved by increasing the knob size or the space between them and by a reduction in the number of tasks requiring dexterity. Automatic recording of data for the AN/VDR-2, MCS and PLRS systems would greatly improve their effectiveness. System particular suggestions are discussed in Appendix C.

V. SUMMARY

Fourteen systems have been analyzed utilizing the BRL E_D algorithm and information from various agencies as referenced in Appendix A. From the analysis recommendations for more effective operations in NBC environments were made and the E_D values for specific tasks were calculated. The values can be used in

conjunction with many different programs in evaluating system effectiveness in NBC environments. The systems were studied and presented in a manner so that the user could use the analysis for a particular system independent of the other systems present. Further testing and analysis of additional tasks will be necessary in the future to completely analyze the impact of Mission Oriented Protective Postures on system and unit effectiveness in NBC environments.

APPENDIX A

DETAILED SYSTEM INFORMATION AND REFERENCES

This appendix contains a listing of references, 12 hour mission profiles and task outlines. The information is cataloged by system to facilitate its use for specific system's analysis. All references are maintained by BRL for further use.

Main Battle Tank M1E1

References:

1) U.S. Armor School
2) Ground Warfare Division, AMSAA
3) Message, Fort Knox, DCD. USAARMS
4) Revised XM-1 MBT Material Need Document ACN 20337
5) FM 71-100 Armored and Mechanized Division Operations
6) TM 9-2350-255-20-2-3-2 Organizational Maintenance Manual for the M1
7) TM 9-2350-255-10-1/2/3 Operations Manuals
8) Test Protocol M1E1 MCC System Desert Phase, Mr. O'Brien HEL Detachment
9) MTD PM for M1E1 Testing, TECOM

12 HOUR MISSION PROFILE

7 Hrs Road Movement
3 Hrs Assembly Area Operations
2 Hrs Engagement

TASK OUTLINE

I. Road Movement:
   20 Miles Paved Road at 35 MPH= 36 Minutes
   45 Miles Secondary Roads at 20 MPH= 135 Minutes
   35 Miles Cross Country at 10 MPH= 210 Minutes

II. Assembly Area Operations (3 Hours)
   a. 1 hour Maintenance and Repair of Major Battle Damage
      1. Replace Road Wheel
      2. Replace Periscope Glass
      3. Repair Scope Generators
   b. 0.5 hour POL
      1. Refuel
      2. Check Oil Levels
      3. Charge Batteries
      4. Preventative Maintenance
   c. 1 hour Loading
      1. 120 Rounds, Main Gun
      2. Machine Gun Rounds
      3. Smoke Rounds
      4. Individual Weapons

d. 0.5 Hour Briefing and Systems Check
    1. Briefings
    2. Inspection
    3. Reports

III. Engagement
    a. Acquire Targets, 46 acquisitions, 24 seconds each = 18.4 minutes
    b. Fire mission, 46 fire missions, 12 seconds each = 9.2 minutes
    c. Movement about the BP, 46 movements, 12 seconds each = 9.2 minutes
    d. Silent Watch

M-3 BRADLEY FIGHTING VEHICLE SYSTEM

Mechanized Infantry Offensive Operations

References:

1) FM 7-7
2) FM 71-100
3) USAARMS
4) BFVS OT RAM Appendix D
5) TM 9-2350-252-10-2 (Operators Manual)
6) BFVS PM Test Data Attached

12 HOUR MISSION PROFILE

Time	
1 Hr.	Crew Functions (Systems Check, Loading, POL and Warning Order)
1 Hr.	Movement to contact
2 Hr.	Engagement
1 Hr.	Silent overwatch/ administrative functions
1 Hr.	Engagement
2 Hr.	Crew Functions (Systems Check, POL, Debriefing and Decon.)
2 Hr.	Maintenance of Battle Damage and Major System Malfunctions
12 Hr.	Total Time

TASK OUTLINE

I. Engagements consist of:
   - 10 TOW Missions, 2 Minutes/Mission = 20 Minutes
   - 12 25MM Missions, 5 Minutes/Mission = 1 Hour
   - 5 Reload TOW Missions, 4 Minutes/Mission = 20 Minutes
   - Movement about the Field of Battle = 20 Minutes

II. Crew Functions
   - 2 Loadings at 15 Minutes Each = 30 Minutes
   - 2 POL actions at 10 Minutes Each = 20 Minutes
   - 2 Warning Order Times at 20 Minutes Each = 40 Minutes
   - 1 Briefing Time = 15 Minutes
   - 1 Debriefing Time = 30 Minutes
   - 3 System Check Times at 15 Minutes Each = 45 Minutes
   - 3 Crew Maintenance times at 20 Minutes Each = 60 Minutes
   - 1 Decontamination of BFVS = 60 Minutes

III. 2 Hrs. Battle Damage and Major Systems Maintenance.

IV. 2 Hrs. Movement to and from Contact.

MLRS

References:

1) RAM Assessment for MLRS in the MLRS ROC (the 12 hr. Profile was taken from D+1 1130-2330)
2) Reaction Time Supplement to the Human Engineering Field Test Report for MLRS, Report Number 4-59300/2R-6
3) Engineering Design Tests- Contractor (EDT-C) Human Factors Evaluation / Reaction Time Test Report for MLRS Report Number 2-55430/OR-004
4) TM 9-1425-646-10 Operator's Manual for MLRS

12 HOUR MISSION PROFILE

(Actual time of day sequence)

2 Hr.	Fire 3 Missiles, Travel 6 Km.
1 Hr.	Fire 2 Missiles, Travel 2 Km.
1.5 Hr.	Load 2 Six-Packs of Missiles
2 Hr.	Fire 1 Missile, Travel 3 Km.
2 Hr.	Fire 2 Missiles, Travel 2 Km.
2 Hr.	Fire 2 Missiles, Travel 1 Km.

Task Outline
(Time for task accomplishment)

1. Chief Maintains Radio Communications with the Platoon Control Point
2. Maintain constant over-watch
3. 11 Missiles Fired at 102 sec./Missile = 18 minutes 4 seconds
4. Travel Distance = 15 Km. 1 Hr. Total Travel Time
5. Load 2 Six Packs of Missiles = 10 minutes 28 seconds
6. POL from Forward Area Refueling Point = 30 minutes
7. Radio Communications = 3 Hrs.
8. Deliberate over-watch = 6 Hrs.
9. Briefing/ Systems Checks = 1 Hr.

Squad Automatic Weapon (SAW) M249
Mechanized Infantry Offensive Operations

References:

1) TM 9-1005-201-10
2) TM 08671A-10/1
3) FM 7-7
4) FM 71-100
5) USAIS, Fort Benning, Ga.
6) Warfare Analysis, AMSAA

12 HOUR MISSION PROFILE

2 Hrs. Pre-dawn Preparation for Movement to include Warning
1 Hr. Movement to Contact
3 Hrs. Engagement and Maneuver
1 Hr. Regroup and Resupply with Maintenance
1 Hr. Administrative Time
2 Hrs. Engagement and Maneuver
2 Hrs. Movement from Battle Area, Cleaning and Decontamination of SAW and limited Maintenance.

Tasks to be Evaluated

IV. Fire the SAW

V. Load the SAW

VI. Silent Watch in the Squad

VII. Run with the SAW

VIII. Walk with the SAW

IX. Field Strip of the SAW

X. Clean the SAW

XI. Change Barrels on the SAW

Advanced Helicopter AH64

References:

1) Project APACHE test done at CDEC
2) AHIP Mission Profile, RAM Assessment
3) Human Engineering Study on Resupply in the Forward Area

12 HOUR MISSION PROFILE

Standard Mission is 4 Hrs.

2 Missions will be accomplished in 12 Hrs.

A Mission consists of:
2 Hrs. Flight to Battle Area
2 Hrs. Engagement
Engagement Time:
a. Target Acquisition
b. Fire Weapon
c. Target Status

Tasks to be Evaluated

I. Navigation
1. Read Maps
2. Read and Use Instruments
3. Fly the AH64
4. Navigation by Outside Observation

II. Target Acquisition (average time 1 minute)

III. Fire Weapon (average time 30 seconds)

IV. Target Status Confirmation and Disengagement (average time 1 minute)

(Total Number of Fire missions = 48)

High Mobility Multi-Purpose Wheeled Vehicle (HMMWV)

References:

1) HMMWV DT Mission Profile for a 20 Hr Engagement
2) AMSAA HMMWV Project Manager
3) FM 71-100, Section 6

TABLE A-1. HMMWV 12 HOUR MISSION ENGAGEMENT

Daytime			
Road Type	Distance (Km.)	Speed (Km/Hr)	Time (Minutes)
Paved	8	80	6
Secondary	24	40	36
Trails	36	25	86
Cross-Country	12	25	29
Load/Unload			3 Hrs
Total			5 Hrs 36 Min
Nighttime			
Road Type	Distance (Km.)	Speed (Km/Hr)	Time (Minutes)
Paved	4	16	15
Secondary	8	8	60
Trails	16	8	120
Cross-Country	6	8	45
Load/Unload			2 Hrs
Total			6 Hrs
Grand Total			11 Hrs 36 Min

Tasks to Evaluate

I. Driving
   1. Paved Road
   2. Cross-Country
   3. Trails
   4. Secondary Roads

II. Navigation

III. Load/Unload

Grader, Motorized, Heavy, Combat Construction Equipment (CCE)

References:

1) TECOM/AMSTE-CT-T
2) Appendix D, Operacional Concept/ Mission Profile for the CCE

Outline of 12 Hour Mission Profile by Task

I. 4 Hrs. Routine Maintenance
   1. POL - 1 Hr.
   2. Major Repair - 1 Hr.
   3. Travel to and from site - 30 Minutes
   4. Plans and Preparation - 15 Minutes
   5. Preventative Maintenance - 15 Minutes

II. 8 Hrs. Operation without Reservicing
   1. Backsloping - 48 Minutes
   2. Crowning - 24 Minutes
   3. Ditching - 2 Hrs. 24 Min.
   4. Finishing - 2 Hrs.
   5. Mixing - 24 Minutes
   6. Scarifying - 24 Minutes
   7. Snow Removal - 24 Minutes
   8. Spreading - 1 Hr. 12 Min.

XM21 Chemical Monitoring System

References:

1) OIC Project SCI Reach XM21 Chemical Monitoring System, CRDC.
2) RAM Rational Report for Remote Sensing Chemical Agent Alarm
3) Coordination Annex for RAM Rational for the XM21 Remote Sensing Chemical Alarm
4) Test Support Package for the XM21, Sections I, II, III
5) TM 3-6665-315-12

12 HOUR MISSION PROFILE

60 Minutes Emplacement/Displacement
25 Minutes Set-up Time
30 Seconds Signal Sensor
42 Seconds Operator Receives Warning
60 Minutes Alarm Relocation Due to Wind Shift

Note: The set-up involves positioning spectral range cards, clearing of the field of view and pacing the area to be monitored.

AN/VDR-2 Radiac Set

References:

1) Director, Radiac Division, U.S. Army Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, NJ 07703
2) Operational Mode Summary/ Mission Profile for the AN/VDR-2

MISSION

The mission chosen, in order to fully utilize the AN/VDR-2, is a mounted ground survey ten hours in length plus two hours for briefing/debriefing and decontamination procedures. In this mission 30 percent of the time will be used to read the instrument and manipulate the switches and dials. Fifty percent of the time will be allocated for driving the vehicle. The remaining 20 percent of the time is allocated for recording data. Data is not transmitted via radio at any time. The mission described is the duty of the NBC recon/ decon squad.

12 HOUR MISSION PROFILE

I. 1 Hr. Briefing and instruction on the survey methods.

II. 5 Hrs. Driving at slow speed with brief stops to perform surveys and record data.

III. 3 Hrs. Operate the AN/VDR-2

IV. 2 Hrs. Record Data

V. 1 Hr. Debriefing, compilation of data and decontamination of personnel and equipment.

Medical Oxygen Generating and Distribution System

References:

1) ADEA, attn: MODE-FDD-CSSV, Fort Lewis, WA 78349
2) Letter of agreement for the On-Site Medical Oxygen Generating and Distribution System

Tasks to be Accomplished

Emplacement/Displacement of the System
Fill a Canister
Hook Hoses to a Surgical Unit

Note: At present there is no mission profile on record. The analysis was made by reviewing the operations of commercial systems used in hospitals. The actual operator time in running this equipment is a very short period of time during a 12 Hr. mission profile.

Selected Battalion Aid Station Operations

References:

1) Army Medical Research Center, Fort Sam Houston, TX.
2) Development of The New BAS Medical Equipment (ROC)

Selected Tasks to be Accomplished in MOPP IV

Apply a Splint
Carry a Litter
Place Patients in the Protective Wrap

SINGARS (Portable FM radio - PRC 77 follow-on)

References:

1) Signal School SINGARS System Manager
2) SINGARS ROC Mission Profile

12 MISSION PROFILE SUMMARY

1 Hr. Code Validation and Assembly of Radio
4 Hrs. Radio Communications
3 Hrs. Receive Only
3 Hrs. Combat Silence during engagement and silent maneuvering
1 Hr. Debriefing and Preventative Maintenance

Tasks Evaluated

Radio Communications
Assembly and set-up of Net
Listen to the Radio
Walk with the Radio
Run with the Radio
Preventative Maintenance

Maneuver Control System (MCS)

References:

1) Project Manager of OPTADS, CORADCOM, Fort Monmouth, NJ 07703
2) The ROC for the MCS
3) The MCS Users Guide
4) Proposed MCS Distribution Plan

12 HOUR MISSION PROFILE SUMMARY

1 Hr. Emplacement
1 Hr. Establishing a Net
3 Hrs. Receiving Information
1 Hr. Sending Reports
3 Hrs. Typing Messages
1 Hr. Displacement
1 Hr. Security
1 Hr. Road Movement

Tasks Evaluated

Emplacement/ Displacement
Radio/ Telephone Communication
Listen to a Radio
Typing on a Terminal
Maintenance
Perimeter Security

Position Location Reporting System (PLRS)

References:

1) U.S. Army Signal Center, PLRS Systems Manager, Fort Gordon, Ga.
2) PLRS Mission Profile from the ROC (attached)

12 HOUR MISSION PROFILE SUMMARY

8.5 Hrs. Normal Operation
1 Hr. Emplacement/ Displacement
2 Hrs. Move
.5 Hr Scheduled Maintenance

Tasks Evaluated

I. Normal Operations
   1. 2 Hrs. Plot Unit Locations on the Terminal
   2. 4 Hrs. Receive Unit Status Reports
   3. 2 Hrs. Send out Status Reports
   4. .5 Hr. Connect Terminals and Adjust Equipment

II. Emplacement/ Displacement
1 Hr. Set up Equipment, Connect Wires and Communication Nets

III. Moving
   1. 1 Hr. Stow Equipment
   2. 1 Hr. Road March

IV. Scheduled Maintenance
   1. Solder Connectors
   2. Clean Filters
   3. Repair Cabinet Hardware

APPENDIX B

Degraded Effectiveness Evaluation References

This appendix contains E_D values for personnel performing tasks at MOPP IV. Calculations and further information are maintained on file at BRL.

TABLE B-1. DEGRADED EFFECTIVENESS (E sub D) EVALUATION REFERENCES

Job	E_D	Reference
Road Movement, Tracked	0.87	1
Heavy Maintenance	0.70	2
POL Activity	0.48	2
Loading Ammunition, Tracked	0.48	2
Briefings and Inspections	0.47	2
Acquiring Targets	0.50	1
Fire mission, M1	0.40	2
Movement about BP	0.46	2
Silent Overwatch*	0.30	2
Radio Communications	0.30	1 and 6
TOW Fire mission	0.45	2
25 MM Fire mission	0.34	2
Reload TOW	0.48	2
Preventative Maintenance	0.55	2
Loading, 25 MM	0.48	2
Fire mission, MLRS	0.37	2 and 7
Loading, MLRS	0.60	7
Fire mission SAW	0.25	3
Fire mission, AH64	0.30	2 and 4
Target Status, AH64	0.30	2 and 4
Reading Maps	0.40	2 and 4
Reading Instruments	0.40	2 and 4
Aircraft Guidance	0.30	2 and 4
Driving HMMWV		0.41
Loading/unloading HMMWV	0.51	2
Earth moving, CCE	0.51	2
Snow removal, CCE	0.51	2
XM21 Hearing Alarm	0.80	2
Operation of AN/VDR-2 and XM-21	0.80	2
Recording Data		0.26
Assembly, SINGARS	0.37	3
Listening, SINGARS	0.48	2
Walking carrying equipment	0.58	2
Running carrying equipment	0.50	2
Small items Maintenance	0.28	2
Emplacement/displacement MCS, PLRS, and XM-21	0.39	2
Receiving Information	0.48	2
Sending Information	0.48	2
Typing	0.33	2 and 5
Plotting on a screen	0.23	2
Repairing Circuit Board	0.75	8
Application of a splint	0.53	2
Carry a litter	0.40	2
Put patients in a protective wrap	0.40	2

* During closed hatch operations (acquiring/detecting targets)

References:

1) CWP3 Test by USACDEC, Exp. number OP953,Feb 81

2) Calculated via the BRL MOPP E_D Algorithm

3) Project Mandrakeroot, USACDEC

4) Project APACHE, USACDEC

5) Signal School Test, June 1982

6) American Acoustical Society Standards for Intelligibility

7) Reaction time supplement to the Human Engineering Field Test Report Number 4-59300/2R-6

8) Maintenance Operations in a Chemical Contaminated Environment, DO-49, April 1984.

APPENDIX C

Suggestions for Improving Compatibility

This appendix is a compilation of system improvements which are considered noteworthy for increased efficiency of equipment operation at the time personnel are at MOPPIV. The discussion addresses the major problems in the system's operation and presents several suggestions for equipment improvement. This analysis is based on study of the system's components and the physiological limitations imposed on the individual while at MOPPIV while operating these systems.

M1E1

An important improvement for reducing degradation due to MOPPIV for the M1E1 was adding the collective protection. Other improvements which could be of further benefit are:

1. Improve optics to include more compatible periscopes especially the drivers periscope.
2. Consider auto-load capability to reduce crew size and mobility encumbrance factors.
3. Provide more crew space, especially for the gunner and commander.
4. Improve the control panel layout to include switch guards and more space between switches, buttons and control handles.
5. Use contrasting colors in marking devices to make it easier to identify system sets.

The M1E1 is a highly technical system and Human Factors considerations such as these can aid in improving crew efficiency.

M-3 Bradley Fighting Vehicle System

The M-3 is a highly mobile infantry system, however the compatibility of the M-3 in an NBC environment when the individuals are in MOPP IV can be improved. Some improvements suggested are:

1. Better design of optical equipment, ie periscopes and sighting devices, to be compatible with the M17 mask.
2. Control panel improvements to include switch guards and more space be tween switches, knobs and buttons.
3. Use of contrasting colors for systems marking to enable the operator to easily distinguish between different operations.

The M-3 was designed primarily for a conventional battlefield, with these and a few other improvements the M-3 can be effective in a NBC environment as well.

MLRS

The MLRS is a highly technical system. There is little that can be done to reduce the complexity of operation. However the MLRS system should have a much better collective protection system in order to allow the personnel to operate without MOPP.

Squad Automatic Weapon (SAW) M249

The SAW is a light weight high rate of fire squad weapon. It appears to be easily decontaminated for most maintenance functions. Some areas for improvement include:

1. Swing away trigger guard for use in a MOPP IV situation.
2. Improvement in the method of changing barrels.
3. Improvement in the ability to stop a "run-away" firing (possibly a change in the belt linkage design).
4. Improvement in the method to clear a weapon and administer a safe from a hang-fire or jam.
5. A better way to carry the weapon in MOPPIV.
6. Cleaning tools that can be used effectively in an NBC environment

Use of the SAW, as with all small arms, will be difficult in the NBC environment primarily due to the decrease of the operator's manual dexterity and visual capabilities while in MOPP IV. More will need to be done to overcome this handicap.

AH64

The AH64 is a highly technical, highly advanced attack helicopter system. The greatest improvement that would enhance the system would be to have a collective protective system that would be adequate enough to allow the pilot and gunner to operate in MOPP 0 in all environments. The weapon system needs improvement, the time of flight is too long (20 seconds average) and the gunner has to guide the weapon to the target. The main problem in flight when in MOPPIV is due to the confining nature of the MOPP gear and the inability to use the heads up display and earphones with the MOPP equipment on. Further information can be found in the CDEC project APACHE summary notes.

HMMWV

The HMMWV is a large vehicle. It has a number of missions: supply, ambulance, and scout. The human factors work on the HMMWV reflects MOPP considerations in that it has power assisted brakes, power steering, and a three speed automatic transmission. The panel is well laid out and switches, knobs and handles are sufficient distances apart. The E_D values are indicative of the problems in navigation due to MOPP alone.

CCE

The CCE is road grader with some armor plate added. The only improvement that could be added would be to have better blade visibility from the cab, otherwise the CCE is easily usable. The E_D values reflect the MOPP effects on

performance due to the general degradation of physiological factors.

XM21 Chemical Agent Alarm

The XM21 Chemical Agent Alarm is an improvement over the M8 system. Chemical detection requires an avenue of detection (range) and some sort of set-up configuration. The sighting methods used on the XM21, although highly improved are probably the most degraded while in the M17 mask. However the use of any optics while in the mask is a problem. The XM21 is set up close to the CP with a very small amount of work and no personal monitoring is needed. The time when personnel are performing a task is small when compared to the time of operation. Reviewing the data available, the system is compatible with in the range of practicability and the latest technological ability to measure chemical levels in an NBC environment.

AN/VDR-2

The Radiac Set is a very well designed piece of individually operated equipment. The only improvement that would be suggested is add an automatic recording device so the user would not have to record data on paper in a NBC environment.

SINGARS

The SINGARS is a light weight portable FM field radio. Some improvements to the SINGARS could be:

1. A small ear phone to go under the MOPP hood into the RTO's ear for listening.
2. A small microphone to be placed in the M17 mask and a simple keying device that could be easily used in MOPP IV.
3. A better method for carrying the radio.
4. A lighter radio
5. A protective cover for the radio for use in NBC environments.
6. A compact antenna system
7. Dials and knobs more easily turnable and farther apart (possibly on the opposite sides of the radio case).

These improvements would enhance the effectiveness of the RTO in a NBC environment.

MCS and PLRS

The MCS and PLRS systems are highly technical systems with complicated operational features. These systems should

be operated in a collectively protected enclosure for maximum efficiency. There is little that can be done to improve these systems for proficient operation in a NBC environment. However some suggestions are:

1. Communications equipment should be made small enough to be worn inside the MOPP equipment (note the SINGARS suggestions).
2. The video package needs to use contrasting color enhancements and large bold symbols for easy reading.
3. The keyboard, knobs, switches and buttons need to be spaced sufficiently far apart to be used with the MOPP gloves on.
4. Minimize the number of connections, lines etc. that need to be manipulated (Emplacement/displacement) for operation.

If operations are done in MOPP IV, these suggestions could improve the effectiveness of the operators.

Overview

These suggestions result from a review of the available document, personal interviews and observations of systems operated while personnel were wearing MOPPIV. It should be noted that all systems were not observed and additional analysis is needed to fully analyze the systems studies, for example the Battalion Aid Station.

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